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Improving Industry 4.0 | A Service Science Perspective

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Abstract

Traditionally, customers were considered to be destructive value stakeholders, independent of products, and distant from production sites. Industry 4.0 is a hot and relevant topic, driven by digital technologies, which has made it possible to incorporate a new economic dimension: the consumer collaborates with the producer in the co-creation of products. Service Science is a multidisciplinary scientific discipline, which studies the interactions between abstract entities called service systems. Considering that value is the result of collaborative interactions between service systems, Service Science appears to be one of the most important emerging scientific fields suitable in the approach and development of Industry 4.0. Given this apparent alignment between the mindset of Industry 4.0 and the philosophical base of the Service Science, the following question arises: How to address Industry 4.0 through the Service Science? As a methodology to find a possible answer to this question, we started from a literature review, in which divergences and gaps between the Service Science Body of Knowledge and its philosophical basis Service-Dominant Logic were explored and identified. The main goal is to understand the potential tension of these two approaches in the context of Industry 4.0. Once the divergences gaps identified, a conceptual framework is conceptualized, through which, the creative interactions of Industry 4.0 can be enhanced and scaled use of Service Science's Theory.

Keywords: Service Science; Service Systems; Industry 4.0; Service-Dominant Logic; Cyber-Physical Systems.

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1. Introduction and motivation

Smart Factories connected to the Internet are a concept that has become an essential subject in recent years for researchers, practitioners and governments, where dynamic “virtual elements” designated as Smart Objects co-created with the customer may be made available in a customized Industrial Foundation Class (IFC) format. However, for Industry 4.0 to involve customers in products’ co-creation, the customer must be considered an indispensable actor [1]. However, in fact, in most of the real cases, the customer is still seen as a strange element, independent and far removed from production sites [2]. From the need to study the value-creation interactions among stakeholders, a new discipline has emerged – Service Science, Management and Engineering (SSME), or only Service Science S|S), as an interdisciplinary scientific field. Anchored in the Service-Dominant Logic (SDL) Axioms [1], the Service Science has adopted the vocabulary, perspective, and the necessary premises to construct its body of knowledge [3]. The element of analysis in S|S is the service system (s|system) - an abstract entity constructed by dynamic resource reconfigurations which must be evaluated and innovated combining the human knowledge in organizations with knowledge in management and technology. The S|S aims to categorize and explain s|systems, including their value-creation interactions [4]. The SDL provides the vocabulary and philosophical foundations for S|S, which must use this vocabulary and philosophical bases to enhance and scale the s|systems [3], guiding the way the world is seen and thus reducing possible disputes over vocabulary mismatch. Governance mechanisms are also known as mechanisms of conflict resolution. Therefore, formalization of the notion of governance interactions and the development of more dispute resolution mechanisms is also a challenge for Service Science Theory [5]. Given this apparent alignment between the mindset of Industry 4.0 and the philosophical base of the Service Science, the following question arises: How to address Industry 4.0 through the Service Science? The objective of this research is thus to find a possible answer to this question, following a sequential methodology: (i) using a systematic literature review, to draw up a list of divergences and gaps between the Service Science and its philosophical basis the SDL; (ii) for each divergence or gap found, also supported by the literature, to propose a framework through which, the creative interactions of Industry 4.0 can be enhanced and scaled supported by the Service Science’s Theory.

2. Literature Review

For activities related to the production of tangible goods (industry), increasingly supported by digital technologies common to intangible assets, S|S may become an exciting discipline at several levels. Firstly, the need for new professional profiles, which can contribute to making the digital service innovation process more systematic and, therefore, a better choice of investment and business management [6]. In this context, in 2009 [5], the ten fundamental concepts of Service Science were published, the Foundations of the Theoretical Body of Service Science.

2.1. Service-Dominant Logic

The perspective, logic, or way of looking at economics has been based on the distinction of products between tangibles or intangibles, which some researchers call *Goods Dominant Logic* (GDL) [7]. This logic is based on the idea that the objective of economic activity is to produce and distribute goods (units of output), usually tangible, which can be stored and transported to the customer who only chooses and buys, and thus, it is only through the production process that goods incorporate value [8]. Based on our own experience as consumers, it may be that the main reason for us buying a product or service is not the value that the producer or seller has assigned to it, but rather depends on what can be done with the product or service. It is bought not for its tangibility, but its intangibility. The customers buy brands, meanings, self-portraits, experiences, knowledge, specialization, and value for life, but the goods themselves are not the reason for purchasing [9]. The acquisition of specialization can be used to manufacture and co-create innovative goods [7]. Possibly inspired and motivated by some renowned economists in the History of Economics, firstly by its founder Adam Smith (1776), the researchers Robert Lusch and Stephen Vargo (2004) in their article entitled *Evolving to a New Logic for Marketing* (S. L. Vargo & Lusch, 2004), proposed a new understanding for trade and value creation, - SDL. In this article, the authors considered that in the SDL mindset, the concept of *service* (in the singular) should presuppose a process of doing something for someone, thus distinguishing itself from the word *services* used in the traditional mindset - the GDL mindset. For the SDL, the concept of *service* would become the common denominator in the trade, leaving no distinction between services (intangible goods) and products (tangible goods) [11]. This new way of observing commercial transactions, where *service* would become the basis of exchange when applied to marketing, implied a continuous analysis of social and economic processes — focused on the operant resources, whereby companies must adopt a new attitude, based on continuous process improvement. The adoption of ongoing improvement strategies is thus, from the SDL perspective, essential to reach sustainability through effectiveness, identifying competencies that become potential competitive advantages and identifying other entities that can benefit from these same competencies. Vargo and Lusch (2008) grounded articulation of the new entity used in the exchange, the *service*, which in their view is the basis of exchange for all types of organizations, regardless of whether they provide services or products, the SDL matrix being defined through eleven Fundamental Premises [12]. A few years later (2016), in their article entitled *Institutions and Axioms: An Extension and Update of Service-Dominant Logic*, the same authors presented a review of all SDL Fundamental Premises, selecting five to become the SDL Axioms, since apparently some of the original concepts overlapped or derived from overlapped concepts [13]. By definitively abandoning the focus on physical resources, such as natural resources, buildings or others, the meaning of *service* from the SDL perspective can no longer be confused with the concept of *services*, which in the traditional view means intangible goods (S. L. Vargo & Lusch, 2004), while *service* is understood as the availability of skills, trust, and knowledge usable for the benefit of others [14]. The concept of *utility*, for SDL, is associated with the fact that physical things, although absolutely essential, are seen as mechanisms to support service. In the same way, the concept of end-user, as a destructive element of the value created by the producer, also ceases to exist. Value is co-credited among actors since goods have no value before being used.

2.2. The Service Science Emergent Scientific Perspective

The Research Manifesto for Services Science (2006) was published by Chesbrough and Spohrer claiming for the creation of a new scientific area to create services expert profiles (Chesbrough & Spohrer, 2006). The Manifesto's authors did not mention the SDL at all, and suggested that Services Science should be the most appropriated designation for this new discipline and the field of applications should be strictly intangible goods transactions only. The following year, in 2007, the scientific foundations of a new Scientific Area called Service

Science (S|S) were published, which would adopt the philosophical basis and vocabulary of the SDL, (P. Maglio & Spohrer, 2007). The authors of this article were the pioneers of Service Science. However, since SD-Logic was already followed by a large community of researchers in that year, the authors of the fundamentals of S|S, when considering SDL as the philosophical basis of S|S, will not have taken into account the future philosophical evolution of SDL itself (Lusch, Vargo, & O'Brien, 2007). In July 2008, the pioneers of SDL [12], seams to claim the authorship of the concepts associated with SDL and proposing an update of its Fundamental Premises as introduced in 2004 [10]. Considering SDL's Axioms as the basic premises of S|S, Spohrer and Maglio (2008) propose that SDL must be the basis of this new scientific area, where the abstract entity designated *service system* would be the *element of study.* This proposal (2008) from S|S pioneers was in line with the earlier proposal from the SDL pioneers (2007), for whom SDL must provide the basis for a review of *Company Theory* based on study of service systems. The authors Laura Anderson, Norm Pass, Spohrer and Tryg Ager, published another key article to consolidate this new scientific area entitled *Service science and Service-Dominant Logic*, in which, in an articulated way, they substantiate the importance of SDL Axioms as the Fundaments of the S|S Body of Knowledge [5]. It is found from the literature review that since this article was published, S|S and SDL have evolved towards the convergence of their principles, each community keeping distinct purposes, and their contributions and criticisms have made these two "movements" increasingly collaborative, solid and complementary. Moreover, it was found that either S|S or S-D Logic have evolved for over a decade. Both now have large communities of researchers, who with their contributions and criticism have made these two "scientific movements" solid, but not always convergent (Paul Maglio, 2016; Stephen Vargo & Lusch, 2017).

2.3. Service Science: The Body of Knowledge

As the Body of Knowledge has been consolidated, the designation *Service Scien*ce has been used as a diminutive or as a substitute for the *Service Science, Management, and Engineering* designation, which according to its main precursors, from 2008 would become the new scientific area, available to develop the skills needed for economic activity based on *service*. By abandoning the *traditional* perspective, where products and services are understood separately, S|S adopted the concept of service exchange [15] and thus, *service* and *service systems* have become the objects of study for this new scientific area, in the sense of its development and improvement in order to create value and innovation for an Ecologically Sustainable and better World. By adopting the vocabulary and philosophy of SDL, the field of application of S|S went far beyond the activities of services, applying its scientific methodologies to all types of economic activities related to the production of tangible and intangible goods. A scientific discipline is a set of methods and standards, accepted and used by a community, to develop a Body of Knowledge that explains and typifies observable phenomena in the world [16]. This led to the construction of S|S Theory, which could support it as a scientific field, considering its interdisciplinarity and considering the Sustainability of the Planet as a transversal concern, in exchanging service and assuming SDL as its philosophical anchor. One of the first difficulties for S|S Theory consolidation is its own interdisciplinarity, to the point that some authors have considered it as a scientific area emerging from a melting pot [4]. The literature review showed that the process of creating the Theoretical Body of S|S has evolved since 2008; firstly, by incorporating SDL concepts such as *value co-creation* and *resource integration* (Vargo & Akaka, 2009) and *service*, which is the basis of all exchanges in the SDL mindset, so that for S|S, all economies have become service economies as well as all companies nowadays being service companies belonging to service ecosystems [13]. This extends the scope of s|systems far beyond specific types of industries or services, concepts that no longer exist in SDL. S|S is concentrated on the value-creation process underlying all exchanges, finally abandoning the focus on physical resources such as natural resources, buildings, or others. This is how Service Science became the discipline that intends to categorize and explain the various types of s|systems, their interactions, and their implications for value creation (Maglio & Spohrer, 2008). Since not all interactions co-create value, it tries to understand the reasons for these normative deviations.

3. Industry 4.0 Operations

The trend in demand towards customized goods can be observed in many sectors. This trend, combined with increasing market volatility, has forced industry to seek new forms of production, based on digital technologies [17]. This tendency to incorporate digital technologies as a way to respond to increasingly customized demand has led governments, practitioners and academics to consider that a new Industrial Age is starting now, the fourth one, characterized by Digital Production combined with the Internet [18] and popularized by the term "Industry 4.0" (I4.0) [38]. To produce in I4.0 mode, production must be supported by Cyber-Physical Systems (CPS), in which products, machines, and customers, connected to the Internet, interact before, during, and after the production process [17]. Digital technologies in the form of Intelligent Connectivity of Smart Devices (ICSD) are the basis of both concepts, representing the main common point between the Internet of Things (IoT) and CPS, which when applied to the relationship between consumers (most common situation) is simple to understand, but when applied to factories, levels of complexity take on another dimension, and this may be the reason why some authors, researchers, and authorities use the term Industrial Internet of Things (IIoT). In any case, the industrial dynamics driven by digital technologies, such as ICSD or IIOT, seem to be reconfiguring the 21st century production model to the point that many authors, researchers, and practitioners consider we are facing a fourth paradigm shift in History or a Fourth Industrial Era. See, for example, Olsen & Tomli, 2020 for a discussion of opportunities and challenges of technologies and operations related with Industry 4.0 and a discussion about new design possibilities for the operations architecture and related processes, in order to alleviate the tension between firm priorities and customer propositions [21]. As with the production of physical goods, this paradigm shift will tend to encompass the maintenance (conservation) of productive means, including the maintenance of CPSs themselves, where the systems' operating conditions derive from the interaction between physical objects and the digital parameters of the processes [22], also extensible to the service sector, so some authors consider that digital technologies are leading to *liquidation* of the economy [18]. Nowadays, parallel to the growth of the IIoT where additive production is perhaps one of the most emblematic results, there has been a change in production, long since boosted by the appearance of new sensorial media on the market, which gathers information in real-time in the most different forms (Olsen & Tomli, 2020). The exponential growth in the use of these new sensor networks will certainly result in an increase in the amount of information, generalizing the term "big data" as dynamic generators of massive information. Big data will challenge the ability of CPSs themselves to screen all the information generated in real-time. The paradigm resulting from big data in IIoT is seen as a reality for which we have to be prepared, and is designated by some authors as "4Vs Paradigm" [3], being interpreted as a sign contrary to the economic advantages of digitalization, since it requires systems to respond in an "immediate way", in order to generate "intelligence".

4. Exploring the divergences and gaps: Service Domonant Logic / Service Science | an Industry 4.0 Perspective

As mentioned above, SDL provides the vocabulary and philosophical foundations for S|S, which must use this vocabulary and philosophical bases in the disciplines, practices and management of business and everyday social affairs [3], guiding the way the world is seen [23] and thus reducing possible disputes over vocabulary mismatch. However, the literature revealed several gaps between these two communities, and the definitions and ways of observing transactions are not yet totally coincident. When analyzing the value co-created coming from Industry 4.0 operations, this becomes a critical issue, since digital transactions require robust governance mechanisms to assist in conflict resolution through the service process.

4.1. Resource Typologies

According to the literature, for S|S, the resources are defined by its usefulness, being natural the high importance of physical and digital ones [24]. Physical and non-physical things are potentially useful [15] and framed in four primary types: people, technology, organizations, and shared information [25]. This is not fully coincident with the SDL mindset, for which any economic entity has two types of resources [26] - operant resources, such as people and organizations and operand resources such as technologies and knowledge, the service being the application of these resources for the benefit of the other [11]. Resources, whether circumstantial or generic, will have a useful life (beginning, middle and end), relative abundance, cost of creation, cost of maintenance, and cost of end of access and use. Formalizing resources that make up a service system in a consistent and valid way, for the different disciplines that comprise Service Science, is one of the purposes of this new scientific area [27]. For S|S, People are physical resources with legal rights; Organizations are non-physical resources with legal rights; Shared Information is non-physical resources treated as property, and Technology is physical resources, treated as property [24]. For SS, Innovation ceases to be a strategic option to become a mental pre-requisite for survival [6], and for this change to be successful, a new professional profile will be needed, supported by a new profile of organizations [4]. In other words, companies and universities need to readjust their talent-building resources to empower the next generation of service innovators. The twenty-first century has an effective workforce with adaptive and innovative professional skills, whose background and leadership abilities allow them to create consensus, both in terms of isolated academic expertise and multifunctional organizations where they work. The literature revealed that for SDL, service system resources consist of operant resources such as people or companies and by operand resources such as technologies and knowledge [13], mitigating aspects related to their ephemerality and the cost of usufruct, among other things. On the other hand, as a resource for S|S can be framed in four typologies (people, technologies, organizations and shared information) [28], and so ephemerality and the cost of usufruct, among other aspects, become fundamentally important, as circumstantial or generic resources have a useful life (beginning, middle and end), relative abundance, a creation cost, a maintenance cost and an end of access cost (Table 1). The distinction among operant and operand resources is useful in the Industry 4.0 context, give the need to promote collaborative networks. More than ephemerality and cost of usufruct, the possibility to create a collaborative way for those resources, became the objective of the New Industrial Era.

Table 1: Framework for Industry 4.0 Resource Typologies

Framework | Resource Typologies		
SDL mindset	Service Science perspective	Industry 4.0?
Operant resources, such as people and organizations and operand resources such as technologies and knowledge.	Recourse is characterized by its usefulness, being usual the higher importance of the physical and digital resources in a first view, but the people, organization, technologies, and shared information are the basis.	Industry 4.0 needs human and digital resources collaborating in a Cyber-physical system. The organizational resource, such as the shared information, having technology as a pillar, are crucial resources for I4.0 implementation. This understood as a particular case of the general typologies of the SDL mindset.

4.2. Value Cocreation

The literature review revealed that according to SDL, value co-creation occurs through the integration of existing resources with others available in a vast array of s|systems, resulting in a contribution to the well-being of those s|systems or ecosystems where they are inserted [13]. However, for S|S, value co-creation is defined as the result of communication, planning, and other intentional interactions among multiple entities [27]. This process continues over time, as new knowledge is generated, and exchanges occur within and among the surrounding s|systems. The gap between the two perspectives seems to be related to interpretation of the outcomes: whereas for SDL, co-creation always results in a positive benefit [13], for S|S, co-creation does not always result in positive value [3]. Since not all activities result in benefit, for S|S, it means that not all interactions between s|systems co-create positive value, i.e., not all outcomes are normative [7]. With the promising idea of a self-prophesying “Fourth Industrial Revolution”, traditional industry boundaries will vanish due to the reorganisation of value creation processes and cause major changes within and across organisations [29], and thus, the study of S|S is challenged to understand the reasons for deviations from normative behaviour, [30] applying scientific methods and understanding to promote the ability to design, develop and size s|systems for commercial and social outcomes that result in efficiency, effectiveness and sustainability [6].

Table 2: Framework for Industry 4.0 Value Cocreation

Framework | Value Cocreation		
SDL mindset	Service Science perspective	Industry 4.0?
Value co-creation occurs through the integration of existing resources with others available in a vast array of s|systems Always result in positive value.	Value co-creation is the result of communication, planning and other intentional interactions among s|systems. Not always result in a positive value.	Industry 4.0 has a new dimension: collaboration customer-provider, supported by Cyber-physical systems. Needs for a strong challenge from S|S perspective in order to achieve better results in terms of efficiency, effectiveness and sustainability.

The mechanisms of value interactions are based on value propositions, intuitively the promises and contracts to which two or more entities agree because they believe that value will result for all entities [28] (Table 2).

4.3. Value Indicators

For S|S, the four main types of measures are quality, productivity, compliance, and sustainable innovation, each corresponding to the concerns of the four key stakeholders [4]. However, perhaps because productivity is strongly associated with physical outputs, this literature review revealed that not only in the SDL community [8,13], but also in publications related to Operations Management, Industry4.0 and the designation of *concerns* has often been used instead of productivity. From the literature review, typically in the digital age, customers' concerns are about quality, providers' concerns about performance, authorities' concerns about compliance and competitors' concerns related to sustainable innovation, without which there is no longer an incentive to innovate [31]. In order to assess the evolution of stakeholder concerns, in S|S, associating the metrics of the evolution of these concerns with Key performance indicators (KPI's) would lead to results that are contrary to those intended, for example, the efficiency evolution value is the inverse of the concern about the efficiency evolution value.

Table 3: Framework for Industry 4.0 Value Computing

Framework | Value Computing		
SDL mindset	Service Science perspective	Industry 4.0?
Goods are purchased for its intangibility	Throughout the service process, customers, providers, authorities, and competitors are computing the value given to themselves	New perspective and paradigm: from performance indicators, the new Indicators referred to the stakeholder's Concerns (KCI). These KCI may be quantitative and qualitative, adopt clear names, and measured throughout the operation, to assess their evolution in terms of Innovation Outcomes to stakeholders.

Thus, in S|S to measure the concerns [12,24], for presentation of the results to be more coincident with this scientific discipline, the Key Indicators might no longer be referred to as *performance* to be referred to instead as *Concerns* (KCI), continuing to be quantitative or qualitative and adopting clear names, measured throughout the service process as well as in traditional KPI, with the aim of measuring their evolution in terms of Innovation Outcomes (IO) (Table 3).

4.4. Service Networks

For the literature review related to SDL, a service ecosystem is a community of interactive entities, composed of organizations or individuals [13] who apply their capacities and play their interdependent roles aiming for its effectiveness and survival. For S|S, s|system networks are communities in which s|systems interact with each other through value co-creation propositions [23]. In these s|system networks, or simply networks, there are also positive aspects from the S|S perspective, thus allowing the share of resources and increasing the capacity of, for example, the investment available to improve these resources [8]. However, catastrophic failures can rain down on many entities when networks are stopped, and this is one of the negative aspects that cannot be overlooked.

Table 4: Framework for Industry 4.0 Service Networks

Framework | Service Networks		
SDL mindset	Service Science perspective	Industry 4.0?
Service Network Ecosystems are communities of interactive entities, composed of organizations or individuals who apply their capacities and play their interdependent roles aiming for its effectiveness and survival	Service Networks are communities in which the s|systems interact through value co-creation propositions	In I4.0 operations mode, the organizations are supported by Cyber-Physical Systems, in which products, machines, and customers, connected to the Internet, interact before, during, and after the production process. New forms of collaboration and interaction are needed, to stakeholder's act in a collaborative and synergy-based way. Case networks are interrupted, the consequences can be extremely serious, being this a challenge in the I4.0 scenario.

Digital platform capabilities provide standards, connectivity, rules, and IT capabilities for mediating the production, search, and delivery of digital content and information goods among users of digital platform ecosystems, a similar meaning to the Service Science perspective, whereas, s|system networks are communities in which s|systems interact with each other through value co-creation propositions (Table 4).

4.5. Stakeholders

For the exchange of service to occur, it is necessary to involve at least two distinct entities, designated in S|S as "stakeholders" and in SDL as "actors". Actors are influential and dynamic elements in their relationships and translations with other actors, described as individuals and groups of individuals. Stakeholders, on the other hand, take meaning from both the processes and consequences of co- production, where actors' meanings are located within distinct historical and cultural systems. Arguably, the aim of co- production is to enable the diverse meanings of stakeholders to influence decision- making. They might be humans sitting at the computer or other systems calling APIs or being called via APIs, while stakeholders have some interest in the system. It is thus expected that when the first stakeholder makes the value proposition, for example, the client conducting a market inquiry or the supplier making an offer, each of the other actors make a different evaluation of the proposal’s value, since each has different objectives. In this context, it is essential that the s|system that makes the value proposition, before making it effective, identifies the concerns that different stakeholders will have when they receive that value proposition, related to perspectives, expectations, access to resources and many others held by each stakeholder. As determined by the S|S Principles, the four primary stakeholders in S|S are the customer, provider, authorities, and competition [32]. If the provider is the author of the value proposition, they must, therefore, consider the customer's perspective, their own perspective, the perspective of the authorities and that of the competition, before sending the proposal, as reasoning in this way will raise different concerns about what should be proposed. The customer, provider, and authority stakeholders are traditionally considered in any business since each one clearly participates in the benefits of the value co-created between the customer and the provider. It is a non-consensual situation, however, when it comes to the "competition" stakeholder. For Spohrer and Maglio (2013), as competitors are part of the business ecosystem context [1], in which there are common shared agreements, rules and benefits, they must be considered as stakeholders, their perspectives contributing to generating additional value to the ecosystem through sustainable innovation [32]. An important requirement of the Digital Factory is to provide stakeholders with information and knowledge support during decision-making activities. For S|S, the customer being the product's co-creator, mapping the service process using a tool such as the service blueprint becomes necessary, to generate new dynamics that bring positive and measurable innovation outcomes to the different stakeholders’ concerns. As one of S|S's main objectives is to innovate in value propositions, it means that to improve IOs, it is necessary to know at the outset what resources are involved in these propositions (Wong, Ignatius, & Soh, 2014). In the digital era, for customer stakeholders, quality concerns are the key indicators of their satisfaction, the evaluation of which must be based on an index of concerns whose reduction leads to satisfaction [4]. For the provider stakeholder of the digital era, performance concerns are the key indicators of their productivity, and evaluation must be based on an index of concerns whose reduction leads to productivity [4]. For the Authority stakeholder in the digital era, compliance concerns remain the key indicators of conformity, and evaluation must be based on an index of concerns whose reduction leads to conformity [4]. Contrary to what it might seem, with regulatory compliance being a factor in transaction costs associated with business in different regions of the world [30], fiscal transparency is increasingly desired by all, as this facilitates carrying out that business.

Table 5: Framework for Industry 4.0 Stakeholders

Framework | Stakeholders		
SDL mindset	Service Science perspective	Industry 4.0?
For the exchange of service to occur, it is necessary to involve at least two "actors," entities as influential and dynamic elements in their relationships and translations with other actors	For the exchange of service to occur, it is necessary to involve at least two distinct "stakeholders," entities that have some interest in the system	Industry4.0 main stakeholders are the customers and providers, which are provided with information and knowledge support throughout the service process. The concerns of stakeholders and respective indicators are crucial to the achievement of objetives.

In this sense, the existence of competition is a fundamental factor for the existence of sustainable innovation, which is a relative measure of value created in the short and medium-term [4] (Table 5).

4.6. Resource Integrators

The Third Service Science Principle is that *the access rights associated with customer and provider resources are reconfigured by mutually agreed to value propositions*, since, in the traditional view (GDL) [33], the producer is the main actor who produces goods and services and consumers are secondary actors or passive recipients [1]. According to GDL, the producer is the source of knowledge and creativity, and therefore also the only source of product innovation [8]. In contrast to the traditional perspective dating back to Adam Smith (1776), in the SDL mindset, all actors are considered resource integrators, networked with other actors, and therefore all are potential innovators or value creators [10]. In this way of viewing the economy, by centring value from the existence of a network of resources which coexist and are available in the imaginary form of "resource density" to benefit others and oneself [1], when liquefied, the resources according to the SDL perspective can be quickly mobilized in time, space or even the actor making the proposal, matching with the Industry 4.0 concept.

Table 6: Framework for Industry 4.0 Resource Integration

Framework | Resource Integration		
SDL mindset	Service Science perspective	Industry 4.0?
By centering value from the existence of a network of resources which coexist and are available in the imaginary form of "resource density" to benefit others and oneself	The resources "liquefication" in Service Science means they can be quickly mobilized in time and space	Industry 4.0 the resources, internal and external towards the products customization

One of the fundaments of S|S is to consider access to s|systems' resources as the necessary link for value creation [32], whenever the resources of both stakeholders are reconfigured in order to propose something to each other. If it is imagined as the fundamental mechanism of interaction between s|system resources or between different s|systems, the reconfiguration of resources then arises, related to the notion of non-ownership or leasing [6] (Table 6).

4.7. Service Exchange

The literature revealed that the definition of *service* is different among the disciplines forming S|S, and S|S defines *service* differently from the SDL community. Since it is a central concept in the co-creation process, it is somewhat incomprehensible that almost a decade later, in the S|S community, *service* is defined as synonymous with *value co-creation*, while for the SDL community, *service* is defined as the application of competence for the benefit of another [13]. The first express action to create *Services Science* may have emerged from the Manifesto presented by Chesbrough and Spohrer (2006). In this document [34], the authors speak about the need to have a new scientific field designated *Services Science Manufacturing and Engineering* to study the activity of services, understood as intangible goods. It may thus be inferred from this that some researchers wrongly maintain the separation between activities related to tangible goods and intangible goods in Service Science. For SDL, *service* (in the singular) is an abstract concept that can be provided directly or through goods, in the form of a common denominator in social and economic exchange [13], as opposed to the term *services* related to intangible assets. In this way, SDL excludes the terminology *services* if understood as an intangible result internally created by an entity, be it a person, company, or a State [13]. With the global shift in the digital economy in recent years, the importance of the concept of service used as a synonym of co-created value seems more appropriate because companies compete through the value understandable by customers which has become the basis of market competitiveness. In this research, although using the understandings of both communities as they are not contradictory, the definition proposed by S|S apparently represents better the meaning of service, in the digital economy context. In the scope of Service Science and oriented towards increasing the value co-created (service), different methods and tools to support service innovation have been introduced by academics and practitioners [3], different methodological tools to support service innovation improvement (Vargo & Lusch, 2004), so that the service exchanged between the supplier and customer provides the desired value and configuration negotiated by both parties. It was also found in the literature review that most of the methodological tools proposed by S|S were developed for the production of intangible goods, which has led academics and practitioners in studies related to efficiency in the production of tangible goods to keep using the traditional tools of lean thinking such as value stream mapping and others which need to be adapted for use in the scope of S|S. This issue found in the literature will probably have resulted from the fact that S|S is a recent [15] scientific discipline which arose from the need to find a discipline for service activities (intangible goods) which only a few years later was extended to tangible goods (Vargo & Lusch, 2016) by adopting the SDL mindset.

Table 7: Framework for Industry 4.0 Service Exchange

Framework | Service Exchange		
SDL mindset	Service Science perspective	Industry 4.0?
Service exchange is the application of competence for the benefit of another	Service exchange means value co-creation	Smart Factories Connected to the Internet has the same meaning as Industry 4.0. It means the service process is a sequence of service functions, which raises the value (co-created)

In I4.0 context, the co-creation value, usually related to intangible goods, must be part of the production of physical goods. The service exchange should be seen in a global way, having in mind the concerns of stakeholders. According to some authors, the tools to interpret and innovate in value interactions depend on customer typology [4]. For example, if it is a business to customer (B2C) context, the service intensity matrix methodological tool allows a good approximation in helping to create different mechanisms for value, from highly customized and highly interactive service offerings to standardized, low-interaction service offerings. Similarly, the *Service Blueprint* methodological tool has been particularly successful in testing new concepts and identifying potential failures or innovation opportunities, and when there is a complex (B2B) organization on the customer side, other tools such as the *Component Business Model* (CBP) have also been found (Table 7).

4.8. Value-Propositions

Another gap found in the literature between the SS perspective and the SDL mindset is related to the sequential process of the search for improvement of the value interactions between entities, this point being especially relevant for this research, since it is related to the methodology to follow for elaboration of the Conceptual Framework, the main objective. At the time of publication of the S|S Principles [27], the SDL community, as it still does today, considered that the analysis and improvement of value propositions should start with the descriptions and nature of the exchanges (value co-creation interactions), aiming to understand how the evolutionary nature of exchange leads to prejudices in understanding the true nature of exchange [26]. On the contrary, for S|S, the sequence must start with the description of the entities, interactions, and outcomes, from which mechanisms must be looked for to support the evolution of value-creation interactions (exchanges) [6].

Table 8: Framework for Industry 4.0 Value Propositions

Framework | Value Propositions		
SDL mindset	Service Science perspective	Industry 4.0?
The value propositions should start with the descriptions and nature of the exchanges (value co-creation interactions), in order to understand the nature of exchange.	The sequence must start with a description of the entities, interactions, and outcomes, from which mechanisms must be looked for to support the evolution of value-creation interactions (exchanges)	The I4,0, once addressed by S|S, must be started by describing and configuring the stakeholder resources, followed by the stakeholders' concerns. Then, the resource access rights must be described using symbologies to facilitate value co-creation. Finally, the concerns evolution must be assessed in terms of Innovation Outcomes.

In the light of Structuration Theory (Giddens, 1984), it may be considered that S|S adopts an evolutionary perspective, since it starts with the structuring of s|systems and the configuration of resources, how to access and use, and innovates in the form of value-creation interactions. In this co-evolutionary process, structuring and innovating are being restricted and mutually adapting to each other (Table 8).

4.9. Discussion

From the literature review it is in this balance that S|S and S-D Logic have evolved for over a decade. Both now have large communities of researchers, who with their contributions and criticism have made these two "scientific movements" solid, but not always convergent [35,36]. On the one hand, the S|S Theoretical Body maintains the four Fundamental Principles and ten basic concepts [4] while the SD-Logic has eleven Fundamental Principles and eight basic concepts [1] as its conceptual basis. This non-convergence results in a potential tension between the two approaches and makes the study of emerging paradigms such as Industry 4.0 difficult [36]. Having initially been thought to be the *Science of Services*, by adopting the philosophical bases and language of SDL, Service Science has become a discipline applicable to both industry and services, with lines separating these two types of activities ceasing to exist. Because it is interdisciplinary and, although recent, Service Science is focused on the study of service system interactions, from which the *service* results as the co-created value, and for S|S, this must be evaluated through indicators of the concerns of the four main stakeholders. The Concern Indicators evolution according to S|S measures the result of reconfiguration of the s|system resources during the service process, which for better visualization must be mapped by an S|S recommended tool and result interpretation evaluated through Innovation Outcomes (IO), which mean the evolution of stakeholders' concerns in different Operation Contexts.

5. Conclusions

In this research, it was explored and discussed some remaining concept divergencies and gaps between the Service Science (S|S) Body of knowledge and the Service Dominant Logic (SDL) mindset, leading to a conclusive framework, through which, the Industry 4.0 can be addressed through the Service Science's Theory. This possible answer found to the research question raised in the introduction of this work, was possible by drawing up a list of divergences and gaps between the Service Science and the SDL and for each one found, supported by the literature, we found a specific framework, allowing the creative interactions of the Industry 4.0 be enhanced and scaled supported by the Service Science's Theory. Industry 4.0 addresses the collection and application of real-time data and information through networking of all individual elements to reduce the complexity of operations, increasing efficiency, and effectiveness with the goal of reducing costs long term. This framework is the main contribution of this research and constitutes the global map to respond to Industry 4.0 challenges through the S|S perspective.From the literature review, Service Science is a multidisciplinary scientific discipline, which studies the interactions between abstract entities called service systems. Considering that value is the result of collaborative interactions between service systems, Service Science appears to be one of the emerging scientific fields suitable in the approach and development of Industry 4.0. It was found that for Service Science, just as there is no separation between tangible and intangible goods, nor is there any "value creator" versus "value destroyer," since all social and economic actors are resource integrators. Entities such as suppliers, customers, families, or any other actors involved in economic activities are "exchange service entities" with the common purpose of co-creating value. The alignment between the Industry 4.0 mindset and the philosophical base of the Service Science, it was conceptualized in this research a way to address Industry 4.0 through the Service Science, and thus answering to the research question posed. By using the following methodology, the main objectives were full achieved: (i) using a systematic literature review, a list of divergences and gaps between the SS and its SDL philosophical basis was drawn up; (ii) for each divergence, also supported by a literature review, a conceptual framework was conceptualized, through which, the creative interactions of Industry 4.0 can be enhanced and scaled use of Service Science's Theory. As already explored, SDL provides a powerful philosophical basis for addressing problems, but it is not a scientific discipline, lacking for a specific method. On the other hand, since Industry 4.0 operations are collaborative and supported by digital technologies, refinement of operations performance will only be possible through holistic methodological approaches, which allow measuring the value generated in all stages of the service process. The development of Industry 4.0 therefore requires methodological analysis in the line of Service Design Research. This research shows that there are S|S aspects and properties already captured by Industry 4.0, however, it remains space for a deep development and construction of a global view, being necessary efforts in order to conceive resource typologies and service networks.

6. Limitations and Recommendations for Future Work

Although it requires to be validated in future practical cases, the framework conceptualized in this research has sufficient theoretical consistency to allow us to conclude that Service Science is an appropriate discipline to address this new Industrial Paradigm. Service Science is a scientific discipline that began to build its Body of Knowledge in recent years, and one of the difficulties found in carrying out this research was the fact that there are still different interpretations of the same concepts between the Service Science and SDL comunities.

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